GUIDELINES ON DIAGNOSTIC IMAGING

Contents

1. Introduction .................................................................................................................................................. 1
   1.1 Incident Reporting ................................................................................................................................. 2
   1.2 Other Resources ...................................................................................................................................... 2
   1.3 Committee Members ............................................................................................................................. 2

2. Guidelines – use of diagnostic imaging for clinical diagnosis
   2.1 Adult acute pyelonephritis (AP) ............................................................................................................ 3
   2.2 Non traumatic acute right iliac fossa (RIF) or pelvis pain ..................................................................... 4
   2.3 Child with hip pain .................................................................................................................................... 5
   2.4 Possible cervical spine injury .................................................................................................................. 6
   2.5 First trimester pregnancy – pain or bleeding ....................................................................................... 7
   2.6 Adult patient with a headache ................................................................................................................. 8
   2.7 Adult with a blunt head injury .................................................................................................................. 9
   2.8 Suspected adult hip fracture .................................................................................................................... 10
   2.9 Suspected renal colic .............................................................................................................................. 11
   2.10 Investigation of a possible subarachnoid haemorrhage ................................................................. 12

1. INTRODUCTION

Diagnostic imaging is an important aspect of an Emergency Department patient workup. Given the high cost of imaging and the potential of patient harm (e.g. radiation dose, contrast reactions), it is essential that imaging be used judiciously.

Representatives from the Australasian College for Emergency Medicine (ACEM) and the Royal Australian and New Zealand College of Radiologists (RANZCR) formed a working group that developed the following imaging guidelines, using available evidence and best practice.

It is strongly suggested that all Emergency Departments and Radiology Departments make these guidelines available to clinical staff and encourage their use.

Emergency clinicians and radiologists should also be encouraged to discuss cases to determine the best imaging modality and pathway to use for a given presentation, especially for difficult and unusual presentations.
1.1 Incident Reporting

Incident Reporting systems are a critical component of high risk/high reliability organisations. The Radiology Events Register (RaER) is an incident reporting system for Medical Imaging. The aim of RaER is to develop a means of systematic data collection and analysis of incidents in radiology, in order to obtain reliable data to assist quality improvement and increase patient safety. RaER incidents most frequently involve the Emergency Department (ED) by a substantial margin.

To report an incident, go to the RaER website (http://www.raer.org) and click on ‘Report an Incident’. You can then enter the reporting site anonymously. The data entry is intuitive and on average takes about five minutes per incident.

Quality improvement at the ED-ED Imaging interface will benefit significantly from a shared approach to incident reporting and analysis, as well as the formulation of appropriate strategies that reduce the risk of patient harm.

1.2 Other Resources

The guidelines presented here have been developed for use in the Emergency Medicine setting. A source of these guidelines is Diagnostic Imaging Pathways (http://www.imagingpathways.health.wa.gov.au/) which has been developed in Perth and endorsed by RANZCR. The extensive set of DIP guidelines encompasses use in all settings as well as Emergency Medicine.

1.3 Committee Members

Dr Yusuf Nagree, Emergency Physician (Chair)      Dr Neil Jones, Radiologist
Dr Carmel Crock, Emergency Physician             Dr Richard Mendelson, Radiologist
Dr Kim Hansen, Emergency Physician               Dr Dinesh Varma, Radiologist
2. GUIDELINES – USE OF DIAGNOSTIC IMAGING FOR CLINICAL DIAGNOSIS

2.1 Adult acute pyelonephritis (AP)

**Notes:**
- The majority of cases are diagnosed clinically with appropriate confirmatory evidence from laboratory testing.
- Routine imaging is not recommended in uncomplicated acute pyelonephritis.
- If obstruction is suspected, prompt imaging should be undertaken.
2.2 Non traumatic acute right iliac fossa (RIF) or pelvis pain

**NON TRAUMATIC ACUTE RIGHT ILIAC FOSSA (RIF) OR PELVIC PAIN**

- History & Examination + BhCG if appropriate

  - High likelihood of appendicitis
  - Atypical for Appendicitis
  - Other causes of right iliac fossa pain that merit further investigation

  **Evidence suggests that imaging, provided treatment is not delayed, can significantly lower the negative appendicectomy rate. This is especially important in young women, where the benefit largely arises from exclusion of gynaecological mimics.**

  **The preferred imaging strategy will depend largely on local availability and expertise and patient factors. In general ultrasound and CT both have similar sensitivity and specificity for diagnosing appendicitis, but each has strengths and weaknesses. The following are some general considerations.**

  - **Young patients, thin patients or pregnant patients**
    - Ultrasound does not involve exposure to ionizing radiation and is therefore preferred
    - Ultrasound RIF/pelvis

  - **Other patients (older patients; obese patients)**
    - CT abdo/pelvis D/W radiology re: contrast

**Notes:**
- Males 16-40 and females < 16 may not need imaging, but advise early surgical referral.
- Early surgical review is best practice – imaging should not be used as a substitute for review nor used to delay review.
- Causes of acute RIF pain include appendicitis, mesenteric adenitis, inflammatory bowel disease, right sided diverticulitis, omental torsion/infarction, renal colic
- Causes of acute RIF pain in women include ectopic pregnancy, pelvic Inflammatory disease (PID), ovarian or ovarian cyst complication, rupture/haemorrhage, and endometriosis.
- CT – sensitivity: 76-100%, specificity: 83-97% for appendicitis. Good for obese patients and for identifying alternate diagnoses. May require intravenous and/or oral contrast. Reasonably high radiation dose.
2.3 Child with hip pain

**Guidelines on Diagnostic Imaging**

2.3 Child with hip pain

**CHILD WITH HIP PAIN**

History and examination

- **History of trauma**
  - Suspicion of infection based on FBC, CRP
    - Yes
    - Urgent Ultrasound hips (consider septic arthritis or osteomyelitis)
      - Yes
      - FBC, CRP
      - Suspicion of infection?
        - No
        - < age 8?
          - No
          - Yes
          - Plain radiography (AP pelvis and frog-leg lateral both hips)
            - Consider slipped femoral epiphysis or irritable hip
          - Yes
          - Orthopaedic review
        - Yes
        - Ultrasound hips (consider Perthes or irritable hip)
  - No
  - Plain Radiography (AP pelvis and lateral hip views)
    - Imaging normal?
      - Yes
      - US normal
        - Yes
        - Appropriate treatment for cause
        - Ortho / paeds review MRI or radio nuclide scanning may be indicated
          - Abnormal
          - Treat
        - No
        - Appropriate treatment based on findings
      - No
      - Consult with paediatrics or orthopaedics re CT or MRI
        - Yes
        - Appropriate treatment for cause
        - Ortho / paeds review MRI or radio nuclide scanning may be indicated
          - Abnormal
          - Treat
        - No
        - Appropriate treatment based on findings

**Notes:**

**Plain Radiographs**
- Imaging of choice for older child with no trauma.
- Slipped capital femoral epiphysis (SCFE) is usually posteromedial and best seen on a frog-leg lateral view.
- Plain radiography should include both hips.
- Plain radiography not sensitive in early osteomyelitis.

**Bone Scans**
- High sensitivity/ specificity for osteomyelitis (which may be multifocal).
- Lower sensitivity for septic arthritis and difficult to distinguish septic arthritis & transient synovitis.
- High ionizing radiation dose.

**US**
- Imaging of choice for young children in the absence of trauma.
- US better for joint effusions.
- No ionizing radiation.
2.4 Possible cervical spine injury

POSSIBLE CERVICAL SPINE INJURY

Harborview Criteria (If yes to any, high risk of c-spine injury)
- Presence of significant head injury
- Presence of focal neurological deficit(s)
- Presence of pelvic or multiple extremity fractures
- Combined impact of accident >50km/h
- Death at the scene of the MVA
- Accident involved a fall from a height of 3m or more

NEXUS criteria (If yes to any, high risk of c-spine injury)
- Posterior midline cervical tenderness
- Evidence of intoxication
- Reduced level of consciousness (GCS ≤ 14)
- Focal Neurological deficit
- Painful distracting injuries.

Other conditions requiring CT neck
- Transient neurology
- Rheumatoid arthritis
- Ankylosing spondylitis

Imaging Required

CANADIAN C-SPINE RULE
Any high-risk factor that mandates radiography?
- Age ≥ 65 yr or dangerous mechanism or paresthesia in extremities

Any low-risk factor that allows safe assessment of range of motion?
- Simple rear-end motor vehicle collision or sitting position in the emergency department or ambulatory at any time or delayed (not immediate) onset of neck pain or absence of midline cervical tenderness

Unable

Able to rotate neck actively?
- Yes
- No

45° left and right

Yes

No imaging of C-spine needed

No

Adequate plain film radiography likely to be obtained

Low risk of c-spine injury

Younger Patients

CT scan of other body region indicated

3-view radiography +/- oblique views

Abnormality seen or inadequate study

Neurology?

No

Abnormal Neurology?

Yes

Patients in whom adequate plain film radiography would be difficult to obtain

High risk of c-spine injury

Older patients

CT scan of other body region indicated (eg: head CT for suspected brain trauma)

CT stat

CT scan of other body region indicated

Philadelphia collar and CT within 8 hours

Choice between CT or plain film evaluation depends on many factors including:
- Risk of a c-spine injury
- Age
- The likelihood of obtaining plain film radiography
- CT scanning becomes more cost effective with concomitant head CT scanning

Examination of Cervical Spine

Ongoing suspicion of cervical spine injury

Targeted CT cervical spine

Clinical Follow-up

MRI

No ongoing suspicion of cervical spine injury

Clinical Follow-up

Normal

CT cervical spine with sagittal and coronal reformatted images

Appropriate management depending on findings

Any neurological signs or for preoperative assessment

Yes

No

Yes

No

No
2.5 First trimester pregnancy – pain or bleeding

**Suspicious features for ectopic pregnancy**:  
- Lateral pelvic pain  
- Pain before bleeding  
**Risk factors**: previous history, IVF, PID, endometriosis, tubal surgery  
**Suspicious features for ruptured ectopic pregnancy**:  
- Haemodynamic instability  
- Shock

**Timing of ultrasound**:  
- Suspicious but stable: asap by suitable operator  
- Unstable: go to theatre  
- Low suspicion: within 24 hours

**FIRST TRIMESTER PREGNANCY**  
**Pain or Bleeding**

- History, Physical and Speculum Exam  
- Ensure that blood group and use of anti-D is considered

- Highly suspicious for ectopic pregnancy?  
  - Yes  
  - No

- Suspicous for ruptured ectopic pregnancy?  
  - No

- FAST available  
  - Yes
  - No

- FAST  
  - Positive
  - Negative

- Clinical stable as assessed by senior doctor  
  - Yes

- Transabdominal US + Transvaginal (TV) US

- Suspicous for ruptured ectopic pregnancy?

- URGENT Obstetrics & Gynaecology discussion

- *Viable Intra-uterine pregnancy

- Non-viable Intra-uterine pregnancy

- Empty uterus No adnexal mass

- Gestational sac <25mm and no foetal pole OR foetal pole <7mm and no heartbeat

- Empty gestational sac >25mm or foetal pole >7mm and no heartbeat

- Empty uterus or sac & no foetal pole ± free fluid with adnexal mass

- *Intra-uterine  
  - Be aware of possibility of simultaneous intra-uterine pregnancy and ectopic pregnancy

- Follow up US as indicated

- Refer to Obstetrics and Gynaecology

- Quantitative β-hCG

- TV ultrasound if not done

- β-hCG < 1500 IU and/or clinically stable?

  - Yes

  - No

  - Repeat β-hCG in 48 hrs

  - Discuss with Obstetrics. Repeat β-hCG and clinical follow up or Laparoscopy

  - Rise ≥ 66%

  - Rise < 66% or clinical deterioration

  - Repeat US in 1 week

  - Laparoscopy

- Failed Pregnancy

- Ectopic pregnancy
2.6 Adult patient with a headache

**ADULT PATIENT WITH A HEADACHE**

- **Meningitis suspected?**
  - Yes
  - Antibiotics without delay
  - **Signs of raised ICP**
    - Altered mental state
    - Papilloedema
    - Focal neurology
  - No
  - Lumbar puncture
  - **CT head**
    - Yes
    - CT normal?
      - Yes
      - Treat according to results
      - No
      - **Are any of the following suspected?**
        - Carotid or vertebral artery dissection
        - Temporal arteritis/Do CRP/ESR
        - Trigeminal neuralgia
        - Cerebral venous thrombosis
        - Cerebrovascular accident
        - If ongoing headache - neurology consult
  - No
  - **Does the patient have any of the following red flag features?**
    - Thunderclap headache (See thunderclap headache pathway above)
    - New headache in the older population
    - New onset headache with history of cancer or immunodeficiency
    - Headache with mental state changes
    - Headache with focal neurological deficit if not previously documented as a migraine with aura
    - Substance abuse with amphetamine or cocaine
    - Patient is pregnant or postpartum
    - Headache causing wakening from sleep or worsened by Valsalva maneuver
    - Progressively worsening headache
    - Significant trauma (See head trauma pathway above)
    - History of seizures in non-epileptic
    - Headache different to usual migraine
    - Anti-coagulation (warfarin LMWH, aspirin and clopidogrel)
    - Significant intracranial pathology unlikely but not excluded
      - CT head
      - **Are any of the following suspected?**
        - Carotid or vertebral artery dissection
        - Temporal arteritis/Do CRP/ESR
        - Trigeminal neuralgia
        - Cerebral venous thrombosis
        - Cerebrovascular accident
        - If ongoing headache - neurology consult

**Notes:**
- CT – generally initial investigation of choice.
- Carotid or vertebral dissection - Magnetic resonance angiography (MRA) considered investigation of choice.
- Temporal arteritis – limited role of imaging. It is a clinical diagnosis in conjunction with ESR and CRP.
- Trigeminal neuralgia – limited role of imaging. Main use is to detect those with a structural cause (e.g. Demyelinating lesions, mass lesions or ectatic vessel).
- Dural venous sinus thrombosis – variable non specific presentation. Combination of MRI and magnetic resonance venography (MRV) is imaging of choice.
2.7 Adult with a blunt head injury

ADULT WITH A BLUNT HEAD INJURY

The Canadian CT Head Rule is a clinical decision rule for adults with a minor head injury, although individual patient factors do need to be taken into account.

High Risk Head Injury
- Focal neurological deficit
- Patients on oral anticoagulants or with a bleeding disorder
- Penetrating skull injury
- Obvious depressed skull fracture
- GCS < 13 at any time since injury
- Post-traumatic seizure
- Unstable vital signs with major trauma

Minor Head Injury
Patient with a history of loss of consciousness, amnesia, or disorientation and a GCS of 13 or greater when examined

Trivial Head Injury
No loss of consciousness, no amnesia and no disorientation

Canadian CT Head Rule
High risk (of abnormality requiring neurosurgical intervention)
- GCS score <15 at 2h after injury
- Suspected open or depressed skull fracture
- Any sign of basal skull fracture (haemotympanum, 'racon' eyes, cerebrospinal fluid otorrhoea/rhinorrhoea, Battle's sign)
- Vomiting two or more times
- Aged 65 or older
Medium risk (for demonstrating brain injury on CT not requiring neurosurgical intervention)
- Retrograde amnesia of more than 30 minutes
- Dangerous mechanism (pedestrian struck by motor vehicle, occupant ejected from motor vehicle, fall from height of more than 3 feet or five stairs

Any High Risk Factors
Head CT

Either of the Medium Risk Factors
Head CT or close observation depending on resources

No High or Medium Risk Factors
Very low risk for significant intracranial injury
Head Injury Advice

Notes: Canadian CT Head Rules
- Prospective validation in Canada reported sensitivity of 100%, specificity of 52% for clinically important brain injury. A Dutch study reported sensitivity of 100% for those requiring neurosurgical intervention but sensitivity of 85% for clinically important brain injury.
- Skull x-rays – rarely used because of the lack of correlation between skull fracture and significant intracranial injury.
- MRI – superior to CT in identifying diffuse axonal injury but lower sensitivity in detection of acute subarachnoid or parenchymal haemorrhage and skull fracture.

Note: NSW Health ‘Closed Head Injury Management Policy’ mandated.
2.8 Suspected adult hip fracture

**SUSPECTED ADULT HIP FRACTURE**

Plain Radiograph (AP Pelvis and lateral hip)

Fracture Seen?

- Yes
  - Senior review of X-ray
  - If seen, treat
  - If not, ongoing suspicion?

- No
  - MRI pelvis and hip available?
    - Yes: Perform MR
    - No: Pelvis/hip CT or Nuclear Medicine Bone scan (localised)

**Definitions**

**Senior:**
- Specialist Radiologist
- Orthopaedic Surgeon
- Emergency Physician
- Senior Registrar

**4 hour rule:**
Radiologist review (1 hour TAT imaging request → report)

**Notes:**
- MRI has sensitivity & specificity close to 100% for occult fracture. CT widely available but may miss impacted fractures or undisplaced fractures parallel to axial plane (sensitivity = 93%).
- Bone Scan – sensitivity 92%, specificity of 95%. Optimal results if delayed up to 72 hours (early scanning may be associated with false negative results).
2.9 Suspected renal colic

**SUSPECTED RENAL COLIC**

- **Over 50?**
  - Yes: First presentation of renal colic
  - No: Ensure other causes of pain are considered

- **Pregnant?**
  - Yes: Consult with radiology & review history of previous imaging
  - No: Stone visible on kidney, ureter, bladder (KUB) radiograph obtained during a recent episode?

- **Is a Low-Dose (radiation dose equal to or less than limited IVP) Non-Contrast Multi-Detector CT scan available?**
  - Yes: Low-Dose Non-Contrast Multi-detector CT
  - No: Contrast CT

- **Urgent vascular consult**
  - No: Renal tract calculus seen?

- **Stable**
  - Yes: Contrast CT
  - No: KUB radiograph +/- urinary tract ultrasound to review progress of ureteric calculus

- **Stone visible on kidney, ureter, bladder (KUB) radiograph obtained during a recent episode?**
  - Yes: Consult with radiology & review history of previous imaging
  - No: Limited IVP

- **Younger patients with typical symptoms/signs of renal colic**

- **Older patients or patients with atypical symptoms**

**Notes:**
- CT considered gold standard – sensitivity of 97%, specificity of 98% compared with IVP (69% and 94%). Low radiation dose protocol seems to be as sensitive & specific as regular protocol.
- Limited IVP – not as accurate as CT and not recommended unless CT not available.
- US – low sensitivity (10-50%) but high specificity (90%). In combination with KUB, sensitivity of 79%, specificity of 90%. Stones missed tend to be small (<5mm). Investigation of choice for pregnant women. Not recommended for older patients due to high incidence of non-renal calculi pathology.
- KUB – useful after CT if stone detected in order to determine visibility on KUB to allow stone follow up if clinically indicated.
- Patients presenting with multiple episodes of typical renal colic in whom CT has previously demonstrated calculi may not require CT at each presentation.
2.10 Investigation of a possible subarachnoid haemorrhage

Notes:
- CT – high sensitivity (90%) if performed within 24 hours of haemorrhage but a normal CT does not exclude haemorrhage. Lower sensitivity in small volume bleeds, delayed CT scanning or low haematocrit (<30%).
- Lumbar Puncture – should be delayed at least 6 hours, preferably 12 hours after onset of headache.

3. DATES AND NOTES

Approved by Council: July 2012

© Copyright – Australasian College for Emergency Medicine. All rights reserved.

34 Jeffcott Street West Melbourne VIC 3003
Ph: 61 3 9320 0444  Web: www.acem.org.au